Journal of Research on the Lepidoptera 1(2):163-168, 1963

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CHANGE OF FOOD PLANT PREFERENCE BY LARVAE OF PIERIS RAPAE CONTROLLED BY STRAIN SELECTION, AND THE INHERITANCE OF THIS TRAIT[1]

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IT HAS BEEN SHOWN that larvae which have previously been fed on a particular food plant are more likely to select that kind of plant than if they had not previously been fed on it (Hovanitz and Chang, 1962 *a* and *b*). These data have shown that there was a shift in selection of mustard or of kale according to whether or not the larvae were from a kale or a mustard strain. Likewise, there was shown a greater selection for nasturtium by larvae previously fed on nasturtium, and indeed, by these same larvae, a greater selection for mustard over kale. This change in selection operates whether the larvae were fed on the changed food-plant for a long time (several generations) or a short time (part of the individual larval life).

In this paper, it is our purpose to test the effect of continued feeding of the larvae of *Pieris rapae* for many generations on mustard and kale by the process of isolating the strains so fed for many generations, then crossing the parental strains to get F_1 individuals and finally crossing the F_1 to get the F_2 segregation.

THE STRAINS

The strains of *Pieris rapae* used in these experiments were derived originally from two sources, both in the Los Angeles Basin of southern California. The first, here designated the kale strain, originated with wild females obtained in a cabbage field *(Brassica oleracea* var. *capitata)* in a truck crop growing area in western Orange County, near Huntington Beach. The other, here designated as the mustard strain, originated in the fields of the Los Angeles State and County Arboretum, where in the spring time *Pieris rapae* may be found in conjunction with black mustard *(Brassica nigra)*. These have probably had no recent contact with cabbage since there are none grown commercially within nine miles of the area. Before testing in the experiments here described, the kale strain had passed through more than ten generations in the labora-

[1]Aided by a grant from the National Science Foundation, Washington, D. C.

tory on kale and the mustard strain had passed through more than six generations in the laboratory on mustard.

Larvae were selected from each and tested for their selection for a series of plants in the manner indicated in a previous paper (Hovanitz and Chang, 1962). The plants used in these tests were mustard *(Brassica nigra),* kale *(Brassica oleracea* var. *acephala),* nasturtium *(Tropaeolum majus),* Isomeris *(Isomeris arborea)* and Cleome *(Cleome lutea).*

STRAIN SELECTIONS

The tests were physically carried out in the manner indicated above. In order to be precise on the nature of any difference to be detected by these experiments, the tests were conducted in large numbers. Twenty-five larvae of each strain were used for twenty or forty trials each, giving a total of six hundred test times for each strain (table I). This was increased to six hundred sixty for the F_1 and nine hundred (with 45 individuals) for the F_2.

	mustard	kale	nasturtium	Isomeris	Cleome	none	no. of larvae	total test times
PARENTS								
On mustard	364 60.66%	119 19.83%	56 9.33%	18 3.0%	12 2.0%	31 5.16%	25	600
On kale	144 24.00%	354 59.0 %	50 8.33%	21 3.5%	15 2.5%	16 2.66%	25	600
F_1								
M♀ x K ♂ (on mustard)	356 59.93%	141 21.36%	90 13.63%	23 3.48%	39 5.91%	11 1.67%	25	660
♀ ♂ (on kale)	328 49.68%	127 19.24%	109 16.51%	33 5.00%	36 5.45%	27 4.09%	25	660
F_2								
M♀ x K ♂ (on mustard)	491 54.55%	145 16.11%	190 21.4 %	30 3.33%	42 4.66%	2 0.22%	45	900
K♀ x M ♂ (on kale)	406 45.11%	146 16.22%	219 24.33%	79 8.77%	39 4.33%	11 1.22%	45	900

Table 1. The comparative mortality and length of larval growth period of various strains of *Pieris rapae.*

The differential selection of the plants by larvae of the two selected strains is clearly made apparent by the curve showing the percentage selection (fig. 1). The larvae from the mustard bred strain selected mustard sixty-one percent of the time as compared with kale twenty percent of the time. The kale strain larvae selected kale fifty-nine percent of the time as compared with mustard twenty-four percent of the time. The two strains show an almost complete reversal of their

preferences with regard to these two plants, their preference being in the direction of the plant utilized as food for several generations.

The selection by larvae of these two strains for the other plants concerned was not significantly different. Nasturtium was selected nine percent of the time by the mustard strain and eight percent of the time by the kale strain. Isomeris was selected three percent of the time by each strain, and Cleome about two percent of the time. About five

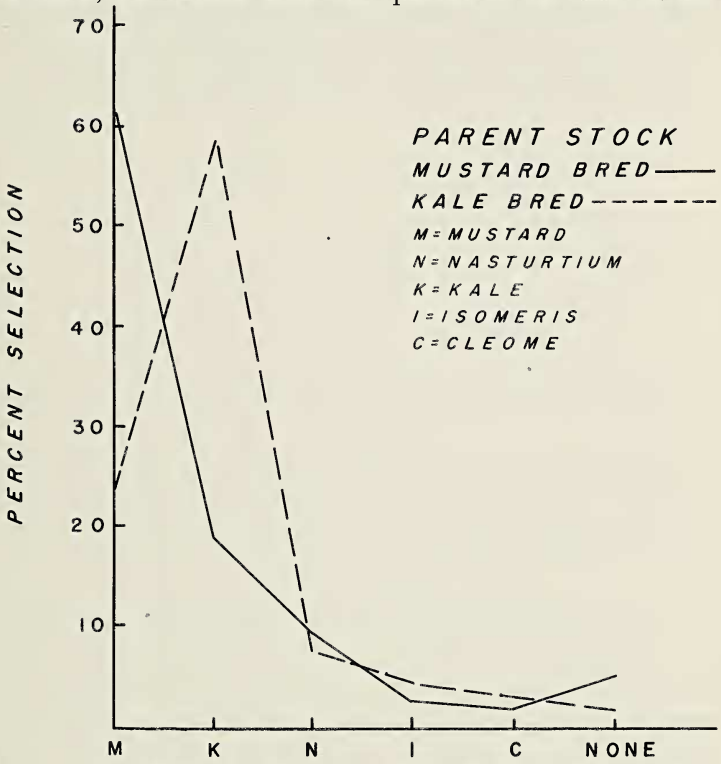

Fig. 1. Curves showing the percentage selection of various food plants by larvae of *Pieris rapae* from a kale and a mustard strain.

percent of the larvae of the mustard strain left test area with no selection as did about three percent of those of the kale strain. Thus, there is no difference observable between these two parental strains in their selection, except with regard to mustard and kale.

THE CROSSES

Adults of the two strains were crossed and the larvae tested for their preference toward a selection of plants. Since there was a possibility of a maternal influence on the inheritance of the food plant selectivity hinted at in a previous experiment, reciprocal crosses were

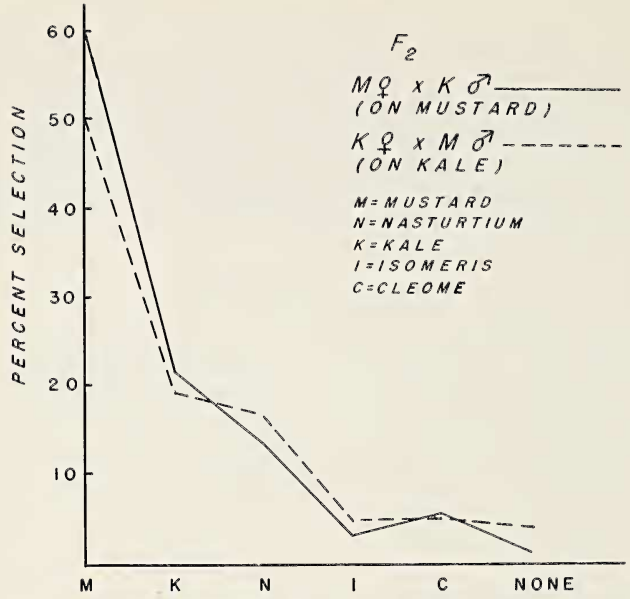

Fig. 2. Curves of the percentage selection of various food plants by larvae of *Pieris rapae* comparing the reciprocal F_1 of the strains shown in figure 1.

made, mustard strain female X kale strain male and vice versa. In each case, however, the larvae were bred on the plant of the female strain until tested. It is now known that it would also have been desirable to have had the reciprocal feeding tests made in addition, as can be seen below.

The F_1 larvae obtained, in which the female parent was from the mustard strain, showed little difference in selection of plants from the parent mustard strain except in an increase in selection of nasturtium and Cleome, neither plant of which was involved in this selection. The reciprocal F_1 larvae obtained from the cross of a kale strain female with a mustard strain male showed a much greater selection of mustard than the kale parent strain, and was more like that of either the mustard parent or of the reciprocal strain indicated (table 1, and fig. 2). In fact, the results of this cross would indicate that the genes for mustard selection are nearly completely dominant over those for kale selection. The cross would also indicate that they are transmitted at least through the male since a mustard strain male was used with a kale strain female and the larvae were bred on kale. The fact that the larvae were bred on kale may be the only reason that the selection was not higher toward mustard than is indicated. As with the reciprocal cross, there was a great increase in selection of nasturtium and Cleome following crossing. This was followed slightly by an increase toward Isomeris though this may not be significant. There is little doubt from these data that the selection of food plants is inherited, and that

"mustard" is dominant over "kale" despite the fact that there is also superimposed upon this inheritance a selective propensity controlled by training during the life of the individual, as has been shown before.

The F_2 crosses were made in the same manner. F_2 larvae of each of the crosses indicated above were obtained and bred on the food plant of the mother (table 1). The tests on these larvae led to basically the same results as on the F_1 larvae with the exception that all percentages were reduced slightly and the percentages for nasturtium were raised greatly. Of significance too is the reduction of the larvae which made no selection at all. The reduction in selection of mustard and kale appears proportional and related to the increase in the selection of nasturtium (fig. 3).

DISCUSSION AND CONCLUSIONS

The data indicated in this paper appear to show that selection of genes for food plant preference occurs over a period of generations when strains are maintained isolated on particular food plants for many generations. These genes do not show maternal inheritance. In the crosses indicated in this paper, genes for selection of mustard over kale are apparently dominant over the reverse. This is indicated by the fact that in the F_1 of the cross kale strain X mustard strain or the reciprocal, selection is similar to that shown by the original mustard strain. The same results are shown for the F_2 but they are not so pronounced. Of great curiosity is the fact that in the F_1 there is an increase in selection for nasturtium, not one of the preferred plants of *Pieris rapae* (Hovanitz and Chang, 1962a). Feeding larvae on nasturtium has shown that there may be greater selection of this plant developed than would ordinarily be present. In the present case, however, no selection of this sort is involved and the increase is significant. This increase is even greater in the F_2 cross than in the F_1, there being a two and one half- to three-fold increase in selection of nasturtium in the F_2 as compared with the parental strains. A much slighter increase is also indicated for Isomeris and Cleome, and a decrease for the number of rejects, that is, those that make no selection. Reasons for this much greater selection for nasturtium and other plants following hybridization are not known nor can they even be guessed at intelligently at this time.

SUMMARY

1. Two food plant strains were developed by selection, one on kale *(Brassica oleracea)* and another on mustard *(Brassica nigra)*.

2. When tested, each of these strains showed a much greater preference for their accustomed food plant than for any other tested. Those tested were mustard, kale, nasturtium, Isomeris and Cleome.

3. When these two strains are crossed, the F_1 hybrids showed a preferential selection most like the mustard parent strain. This indicates that the gene(s) for mustard is dominant over that for kale. There is

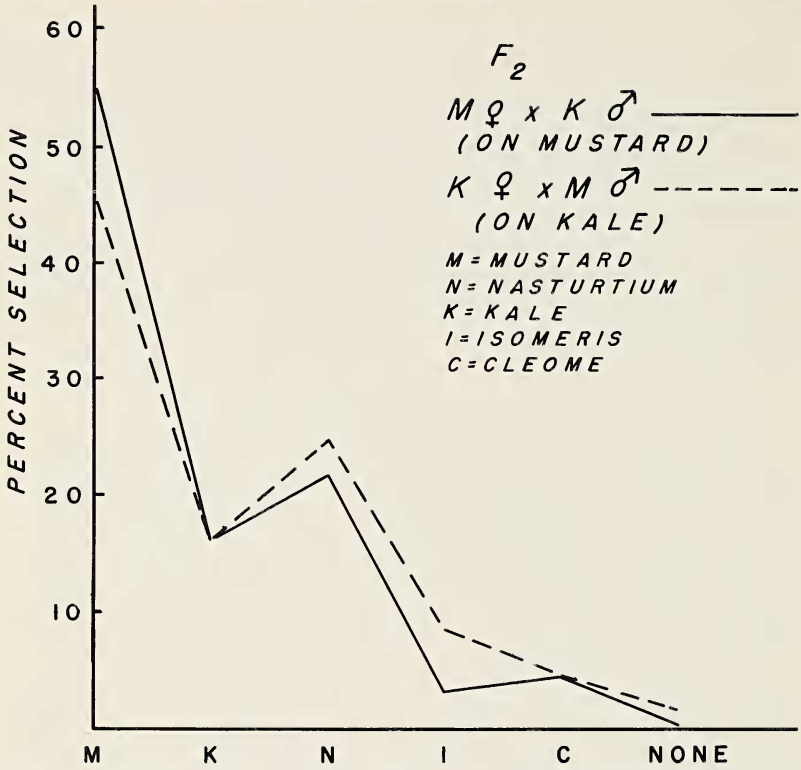

Fig. 3. Curves of the percentage selection of various food plants by larvae of *Pieris rapae* comparing the reciprocal F_2 of the strains shown in figures 1and 2.

also indicated a slight increase in selection of the other plants tested.

4. The F_2 of this cross showed results similar to the F_1, namely a selection in favor of mustard rather than kale whether or not the female parent had originally come from the mustard or the kale strain. Thus, maternal inheritance is not indicated here even though maternal effects were indicated on growth rate and mortality data in a previous paper.

5. As had been indicated, feeding the larvae even a short time on one particular food plant may influence it to have a preferential selection for that plant.

6. In the F_2 there is indicated a strongly increased preferential selection toward nasturtium which was not selected in any previous strain. This increase is also indicated slightly toward Isomeris and Cleome. No reason is advanced at this time for these results.

LITERATURE CITED

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